CLAIMS

What is claimed is:

1. An apparatus for generating optical pulses, wherein each pulse may have individualized characteristics, the apparatus comprising:

laser means for generating the bursts of composite pulses;

control means that controls the laser means; and

beam manipulation means for monitoring the wavelength characteristics of the pulses comprising the composite pulse bursts and generating feedback data for the control means for pulse wavelength control.

2. An apparatus as claimed in claim 1, wherein the laser means comprises a fiber amplifier.

3. An apparatus as claimed in claim 2, wherein the laser means further comprise at least one stretcher grating and at least one grating compressor.

4. The apparatus as claimed in claim 1, wherein the beam manipulation means comprise:

a power meter that measures the power of the laser pulses output from the laser means;

a photodiode that measures a repetition rate of the laser pulses; and

an optical gating device that measures the pulse duration of the laser pulses.

5. The apparatus as claimed in claim 1, wherein the beam manipulation means comprise means for optically converting the fundamental frequency of a percentage of the generated laser pulses to one or more other optical frequencies.

6. The apparatus as claimed in claim 5, the means for converting an optical frequency comprising at least one optical member that converts a portion of the fundamental of the laser pulses into at least one higher order harmonic signal.

7. The apparatus as claimed in claim 6, wherein the optical member device comprises at least one non-linear crystal device with a controller that controls the orientation of the at least one non-linear crystal with respect to the input laser pulses.

8. The apparatus as claimed in claim 5, wherein the means for converting an optical frequency further comprise a spectrometer that measures predetermined parameters of pulses output from the non-linear crystal device and generates feedback for the control means.

9. The apparatus as claimed in claim 1, wherein the beam manipulation means comprises:

a telescopic optical device to control the size, shape, divergence or polarization of the laser pulses input into the beam manipulation means; and

steering optics that control an impingement location of the laser pulses on the target substrate.

10. The apparatus as claimed in claim 9, the apparatus further comprising a beam profiler that monitors characteristics of laser pulses and generates feedback for the control means.

11. An end use device for modifying the refractive index of a target substrate, wherein the end device at least comprises an apparatus according to claim 1.

12. An end use device for surface marking, sub-surface marking and surface texturing of a target substrate, wherein the end device at least comprises an apparatus according to claim 1.

13. An end use device for fabricating holes, channels or vias in a target substrate, wherein the end device at least comprises an apparatus according to claim 1.

14. An end use device for the deposition or removal of thin layers of material on a target substrate, wherein the end device comprises an apparatus according to claim 1.

15. An end use device for the joining, welding or fusing of transparent materials, wherein the end device comprises an apparatus according to claim 1.

16. An apparatus for generating optical pulses, wherein each pulse may have individualized characteristics, the apparatus comprising:

laser means for generating the bursts of composite pulses;

control means that controls the laser means; and

beam manipulation means for monitoring the pulsewidth characteristics of the pulses comprising the composite pulse bursts and generating feedback data for the control means for pulsewidth control.

17. An apparatus as claimed in claim 16, wherein the laser means comprises a fiber amplifier.

18. An apparatus as claimed in claim 17, wherein the laser means further comprise at least one stretcher grating and at least one grating compressor.

19. The apparatus as claimed in claim 16, wherein the beam manipulation means comprise an optical gating device that measures the pulse duration of the laser pulses.

20. The apparatus as claimed in claim 19, wherein the beam manipulation means further comprise:

a power meter that measures the power of the laser pulses output from the laser means; and

a photodiode that measures a repetition rate of the laser pulses.

21. The apparatus as claimed in claim 16, wherein the beam manipulation means comprise means for optically converting the fundamental frequency of a percentage of the generated laser pulses to one or more other optical frequencies.

22. The apparatus as claimed in claim 21, the means for converting an optical frequency comprising at least one optical member that converts a portion of the fundamental of the laser pulses into at least one higher order harmonic signal.

23. The apparatus as claimed in claim 22, wherein the optical member device comprises at least one non-linear crystal device with a controller that controls the orientation of the at least one non-linear crystal with respect to the input laser pulses.

24. The apparatus as claimed in claim 21, wherein the means for converting an optical frequency further comprise a spectrometer that measures predetermined parameters of pulses output from the non-linear crystal device and generates feedback for the control means.

25. The apparatus as claimed in claim 16, wherein the beam manipulation means comprises:

a telescopic optical device to control the size, shape, divergence or polarization of the laser pulses input into the beam manipulation means; and

steering optics that control an impingement location of the laser pulses on the target substrate.

26. The apparatus as claimed in claim 16, the apparatus further comprising a beam profiler that monitors characteristics of laser pulses and generates feedback for the control means.

27. An end use device for modifying the refractive index of a target substrate, wherein the end device at least comprises an apparatus according to claim 16.

28. An end use device for surface marking, sub-surface marking and surface texturing of a target substrate, wherein the end device at least comprises an apparatus according to claim 16.

29. An end use device for fabricating holes, channels or vias in a target substrate, wherein the end device at least comprises an apparatus according to claim 16.

30. An end use device for the deposition or removal of thin layers of material on a target substrate, wherein the end device comprises an apparatus according to claim 16.

31. An end use device for the joining, welding or fusing of transparent materials, wherein the end device comprises an apparatus according to claim 16.

32. An apparatus for generating optical pulses, wherein each pulse may have individualized characteristics, the apparatus comprising:

laser means for generating the bursts of composite pulses;

control means that controls the laser means; and

beam manipulation means for monitoring the temporal delay characteristics of the pulses comprising the composite pulse bursts and generating feedback data for the control means for temporal delay control.

33. An apparatus as claimed in claim 32, wherein the laser means comprises a fiber amplifier.

34. An apparatus as claimed in claim 33, wherein the laser means further comprise at least one stretcher grating and at least one grating compressor.

35. The apparatus as claimed in claim 32, wherein the beam manipulation means comprise a photodiode that measures the temporal delay.

36. The apparatus as claimed in claim 35, wherein the beam manipulation means further comprise:

a power meter that measures the power of the laser pulses output from the laser means and

an optical gating device that measures the pulse duration of the laser pulses.

37. The apparatus as claimed in claim 32, wherein the beam manipulation means comprise means for optically converting the fundamental frequency of a percentage of the generated laser pulses to one or more other optical frequencies.

38. The apparatus as claimed in claim 37, the means for converting an optical frequency comprising at least one optical member that converts a portion of the fundamental of the laser pulses into at least one higher order harmonic signal.

39. The apparatus as claimed in claim 38, wherein the optical member device comprises at least one non-linear crystal device with a controller that controls the orientation of the at least one non-linear crystal with respect to the input laser pulses.

40. The apparatus as claimed in claim 37, wherein the means for converting an optical frequency further comprise a spectrometer that measures predetermined parameters of pulses output from the non-linear crystal device and generates feedback for the control means.

41. The apparatus as claimed in claim 32, wherein the beam manipulation means comprises:

a telescopic optical device to control the size, shape, divergence or polarization of the laser pulses input into the beam manipulation means; and

steering optics that control an impingement location of the laser pulses on the target substrate.

42. The apparatus as claimed in claim 41, the apparatus further comprising a beam profiler that monitors characteristics of laser pulses and generates feedback for the control means.

43. An end use device for modifying the refractive index of a target substrate, wherein the end device at least comprises an apparatus according to claim 32.

44. An end use device for surface marking, sub-surface marking and surface texturing of a target substrate, wherein the end device at least comprises an apparatus according to claim 32.

45. An end use device for fabricating holes, channels or vias in a target substrate, wherein the end device at least comprises an apparatus according to claim 32.

46. An end use device for the deposition or removal of thin layers of material on a target substrate, wherein the end device comprises an apparatus according to claim 32.

47. An end use device for the joining, welding or fusing of transparent materials, wherein the end device comprises an apparatus according to claim 32.

48. An apparatus for generating optical pulses, wherein each pulse may have individualized characteristics, the apparatus comprising:

laser means for generating the bursts of composite pulses;

control means that controls the laser means; and

beam manipulation means for monitoring a variable repetition rate of the composite pulse bursts and generates feedback data for the control means for the variable repetition rate.

49. An apparatus as claimed in claim 48, wherein the laser means comprises a fiber amplifier.

50. An apparatus as claimed in claim 49, wherein the laser means further comprise at least one stretcher grating and at least one grating compressor.

51. The apparatus as claimed in claim 48, wherein the beam manipulation means comprise a photodiode that measures a repetition rate of the laser pulses.

52. The apparatus as claimed in claim 51, wherein the beam manipulation means comprise:

a power meter that measures the power of the laser pulses output from the laser means; and

an optical gating device that measures the pulse duration of the laser pulses.

53. The apparatus as claimed in claim 48, wherein the beam manipulation means comprise means for optically converting the fundamental frequency of a percentage of the generated laser pulses to one or more other optical frequencies.

54. The apparatus as claimed in claim 53, the means for converting an optical frequency comprising at least one optical member that converts a portion of the fundamental of the laser pulses into at least one higher order harmonic signal.

55. The apparatus as claimed in claim 54, wherein the optical member device comprises at least one non-linear crystal device with a controller that controls the orientation of the at least one non-linear crystal with respect to the input laser pulses.

56. The apparatus as claimed in claim 53, wherein the means for converting an optical frequency further comprise a spectrometer that measures predetermined parameters of pulses output from the non-linear crystal device and generates feedback for the control means.

57. The apparatus as claimed in claim 48, wherein the beam manipulation means comprises:

a telescopic optical device to control the size, shape, divergence or polarization of the laser pulses input into the beam manipulation means; and

steering optics that control an impingement location of the laser pulses on the target substrate.

58. The apparatus as claimed in claim 57, the apparatus further comprising a beam profiler that monitors characteristics of laser pulses and generates feedback for the control means.

59. An end use device for modifying the refractive index of a target substrate, wherein the end device at least comprises an apparatus according to claim 48.

60. An end use device for surface marking, sub-surface marking and surface texturing of a target substrate, wherein the end device at least comprises an apparatus according to claim 48.

61. An end use device for fabricating holes, channels or vias in a target substrate, wherein the end device at least comprises an apparatus according to claim 48.

62. An end use device for the deposition or removal of thin layers of material on a target substrate, wherein the end device comprises an apparatus according to claim 48.

63. An end use device for the joining, welding or fusing of transparent materials, wherein the end device comprises an apparatus according to claim 48.

64. An apparatus for generating optical pulses, wherein each pulse may have individualized characteristics, the apparatus comprising:

laser means for generating the bursts of composite pulses;

control means that controls the laser means; and

beam manipulation means for monitoring the wavelength, pulsewidth and variable repetition rate characteristics of the pulses comprising the composite pulse bursts and generating feedback data for the control means for pulse wavelength, pulsewidth and repetition rate control.

65. An apparatus as claimed in claim 64, wherein the laser means comprises a fiber amplifier.

66. An apparatus as claimed in claim 65, wherein the laser means further comprise at least one stretcher grating and at least one grating compressor.

67. The apparatus as claimed in claim 64, wherein the beam manipulation means comprise:

a photodiode that measures a repetition rate of the laser pulses; and

an optical gating device that measures the pulse duration of the laser pulses.

68. The apparatus as claimed in claim 67, wherein the beam manipulation means further comprise a power meter that measures the power of the laser pulses output from the laser means.

69. The apparatus as claimed in claim 64, wherein the beam manipulation means comprise means for optically converting the fundamental frequency of a percentage of the generated laser pulses to one or more other optical frequencies.

70. The apparatus as claimed in claim 69, the means for converting an optical frequency comprising at least one optical member that converts a portion of the fundamental of the laser pulses into at least one higher order harmonic signal.

71. The apparatus as claimed in claim 70, wherein the optical member device comprises at least one non-linear crystal device with a controller that controls the orientation of the at least one non-linear crystal with respect to the input laser pulses.

72. The apparatus as claimed in claim 69, wherein the means for converting an optical frequency further comprise a spectrometer that measures predetermined parameters of pulses output from the non-linear crystal device and generates feedback for the control means.

73. The apparatus as claimed in claim 64, wherein the beam manipulation means comprises:

a telescopic optical device to control the size, shape, divergence or polarization of the laser pulses input into the beam manipulation means; and

steering optics that control an impingement location of the laser pulses on the target substrate.

74. The apparatus as claimed in claim 73, the apparatus further comprising a beam profiler that monitors characteristics of laser pulses and generates feedback for the control means.

75. An end use device for modifying the refractive index of a target substrate, wherein the end device at least comprises an apparatus according to claim 64.

76. An end use device for surface marking, sub-surface marking and surface texturing of a target substrate, wherein the end device at least comprises an apparatus according to claim 64.

77. An end use device for fabricating holes, channels or vias in a target substrate, wherein the end device at least comprises an apparatus according to claim 64.

78. An end use device for the deposition or removal of thin layers of material on a target substrate, wherein the end device comprises an apparatus according to claim 64.

79. An end use device for the joining, welding or fusing of transparent materials, wherein the end device comprises an apparatus according to claim 64.

80. An apparatus for generating optical pulses, wherein each pulse may have individualized characteristics, the apparatus comprising:

laser means for generating the bursts of composite pulses;

control means that controls the laser means; and

beam manipulation means for monitoring the polarization characteristics of the pulses comprising the composite pulse bursts and generating feedback data for the control means for polarization control.

81. An apparatus as claimed in claim 80, wherein the laser means comprises a fiber amplifier.

82. An apparatus as claimed in claim 81, wherein the laser means further comprise at least one stretcher grating and at least one grating compressor.

83. The apparatus as claimed in claim 80, wherein the beam manipulation means comprise:

a power meter that measures the power of the laser pulses output from the laser means;

a photodiode that measures a repetition rate of the laser pulses; and

an optical gating device that measures the pulse duration of the laser pulses.

84. The apparatus as claimed in claim 80, wherein the beam manipulation means comprise means for optically converting the fundamental frequency of a percentage of the generated laser pulses to one or more other optical frequencies.

85. The apparatus as claimed in claim 84, the means for converting an optical frequency comprising at least one optical member that converts a portion of the fundamental of the laser pulses into at least one higher order harmonic signal.

86. The apparatus as claimed in claim 85, wherein the optical member device comprises at least one non-linear crystal device with a controller that controls the orientation of the at least one non-linear crystal with respect to the input laser pulses.

87. The apparatus as claimed in claim 84, wherein the means for converting an optical frequency further comprise a spectrometer that measures predetermined parameters of pulses output from the non-linear crystal device and generates feedback for the control means.

88. The apparatus as claimed in claim 80, wherein the beam manipulation means comprises:

a telescopic optical device to control the size, shape, divergence or polarization of the laser pulses input into the beam manipulation means; and

steering optics that control an impingement location of the laser pulses on the target substrate.

89. The apparatus as claimed in claim 88, the apparatus further comprising a beam profiler that monitors characteristics of laser pulses and generates feedback for the control means.

90. An end use device for modifying the refractive index of a target substrate, wherein the end device at least comprises an apparatus according to claim 80.

91. An end use device for surface marking, sub-surface marking and surface texturing of a target substrate, wherein the end device at least comprises an apparatus according to claim 80.

92. An end use device for fabricating holes, channels or vias in a target substrate, wherein the end device at least comprises an apparatus according to claim 80.

93. An end use device for the deposition or removal of thin layers of material on a target substrate, wherein the end device comprises an apparatus according to claim 80.

94. An end use device for the joining, welding or fusing of transparent materials, wherein the end device comprises an apparatus according to claim 80.

95. An apparatus for impinging laser pulses on a target substrate, the apparatus comprising:

laser means for generating the bursts of composite pulses;

control means that controls the laser means; and

beam manipulation means for monitoring characteristics of the composite pulse bursts output from the laser means to generate feedback data for the control means, and for manipulating the characteristics of the composite pulse bursts; and

means for positioning the target substrate.

96. The apparatus as claimed in claim 95, wherein the beam manipulation means comprising:

a power meter that measures the power of the laser pulses output from the laser means;

a photodiode that measures the repetition rate of the laser pulses; and

an optical gating device that measures the pulse duration of the laser pulses.

97. The apparatus as claimed in claim 95, wherein the beam manipulation means comprise means for optically converting the fundamental frequency of a percentage of the generated laser pulses to one or more other optical frequencies.

98. The apparatus as claimed in claim 97, the means for converting an optical frequency comprising at least one optical member that converts a portion of the fundamental of the laser pulses into at least one higher order harmonic signal.

99. The apparatus as claimed in claim 98, wherein the optical member device comprises at least one non-linear crystal device.

100. The apparatus as claimed in claim 99, wherein the non-linear crystal device further comprises a controller that controls the orientation of the at least one non-linear crystal with respect to the input laser pulses.

101. The apparatus as claimed in claim 99, wherein the non-linear crystal device further comprises a dual-lens telescope that focuses the input laser pulses into the at least one non-linear crystal, wherein the at least one non-linear crystal is disposed between the lenses of the telescope.

102. The apparatus as claimed in claim 101, wherein the dual-lens telescope collimates the output of the at least one non-linear crystal.

103. The apparatus as claimed in claim 98, wherein the means for converting an optical frequency further comprise a spectrometer that measures predetermined parameters of pulses output from the non-linear crystal device.

104. The apparatus as claimed in claim 95, wherein the beam manipulation means comprises:

a telescopic optical device to control the size, shape, divergence or polarization of the laser pulses input into the means for manipulating; and

steering optics that control the impingement location of the laser pulses on the target.

105. The apparatus as claimed in claim 104, the apparatus further comprising:

a beam profiler that monitors characteristics of laser pulses output from the telescopic optical device; and

a position detector that determines a position of the laser pulses output from the steering optics.

106. The apparatus as claimed in claim 104, wherein the telescopic optical device comprises at least two cylindrical lens telescopes aligned along an optical axis traversed by the laser pulses.

107. The apparatus as claimed in claim 97, wherein the apparatus further comprises:

means for directing the fundamental and/or converted frequencies of the laser pulses and the impingement location of the pulses with respect to the target substrate;

means for focusing the fundamental and/or converted frequencies of the laser pulses;

108. The apparatus as claimed in claim 95, the means for positioning comprising:

a mounting surface for translating the target with respect to the laser pulses; and

a motion control device coupled to the mounting surface.

109. The apparatus as claimed in claim 108, the means for positioning further comprising an environmental chamber, wherein the mounting surface and the motion control device are disposed within the environmental chamber.

110. An end use device for modifying the refractive index of a target substrate, wherein the end device at least comprises an apparatus according to claim 95.

111. An end use device for surface marking, sub-surface marking and surface texturing of a target substrate, wherein the end device at least comprises an apparatus according to claim 85.

112. An end use device for fabricating holes, channels or vias in a target substrate, wherein the end device at least comprises an apparatus according to claim 95.

113. An end use device for the deposition or removal of thin layers of material on a target substrate, wherein the end device comprises an apparatus according to claim 95.

114. An end use device for the joining, welding or fusing of transparent materials, wherein the end device comprises an apparatus according to claim 95.